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THE OCTOBER 1967 CURRENT DETERMINATIONS AT THE FIVE MILE AND AU TRAIN PLANT SITES

Final Report

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Introduction

This report describes in full the work done under Project ORA-68-306-P1, Oxford Paper Company, entitled LAKE SUPERIOR CURRENTS. The report is submitted in this simple form to enable it to be put into the hands of the Company at the earliest possible time.

The requirements of the project were to assess as well as possible in the limited time available the characteristics of Lake Superior water currents adjacent to two possible pulp-mill sites. The sites are situated at the base of Five Mile Point, at the position of the letter "A" in Figure 1, and on a promontory west of Au Train Bay and south of Au Train Island, at the position of the letter "B" in Figure 1.

At each plant site the immediate question was whether effluent from the mill's outfall would reach the mill's intake. At each plant site there was also an important ancillary question as to whether the mill effluent could reach the municipal water intake of Munising, Michigan.

The first three weeks of October were chosen as being the probable last good weather prior to the onset of the fall storms.

Procedure

Field work was carried out from the chartered fishtug, REX, owned by Mr. Roger Tallman of Munising. This arrangement proved very satisfactory.

Because time was too short to allow the obtaining of Rhodamine dye and a suitable fluorometer, currents were measured with a shortened version of the U. S. Coast & Geodetic Survey current pole. Numerous areas of shoal water near each of the plant sites made shortened current poles necessary to minimize going aground.

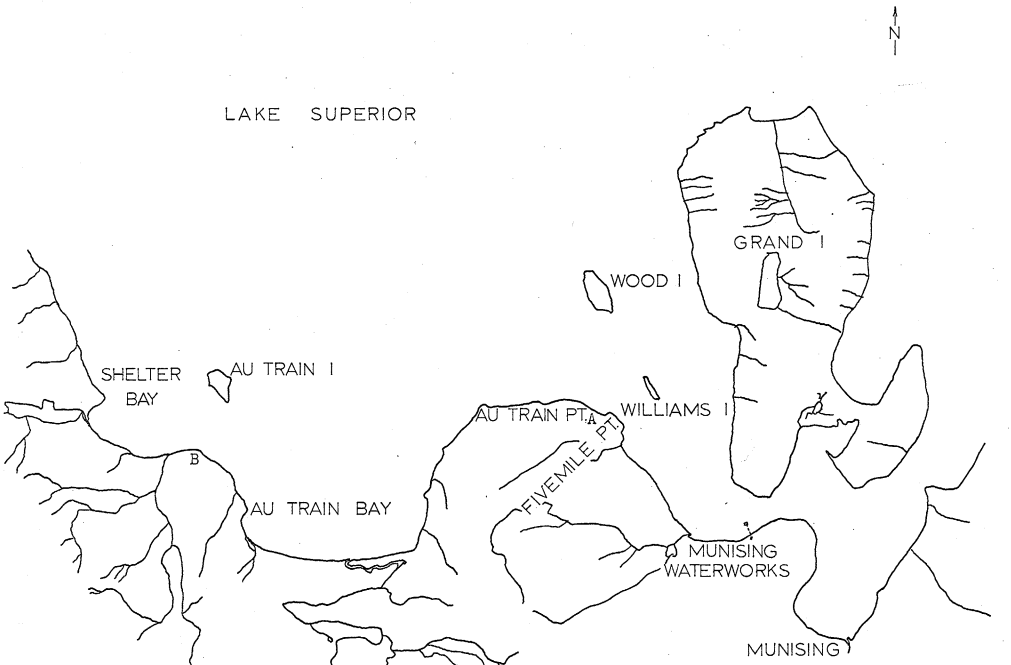

Figure 1. Showing the region, the plant sites (A and B), and the Munising intake.

The current poles consisted of 4-foot lengths of commercial 2 x 4 dimension stock. Each carried a brick at its lower end for ballast and extra current drag. The poles floated vertically with about 10 inches exposed above the water surface. Each pole was numbered and carried a small orange pennant at its top.

At each plant site the current poles were set in different depths of water and in positions so chosen that they would sweep over the position of the proposed mill-outfall.

Positions of setting, positions during the run, and positions of pole recovery were determined by sextant fixes to charted landmarks ashore. Setting positions and during-run positions are indicated by small dots along the trajectory of each pole in the figures beginning with Figure 2. Recovery positions are indicated by arrowheads in these figures. The identifying pole numbers are indicated at the beginning of each pole run.

Each pole was followed as long as the conditions of the day would permit. On some days poles went aground in shallow water, whence they were recovered and reset; when this occurred a dotted line connects the point of grounding to the point of resetting.

Wind velocities were measured in the field with a hand-held anemometer.

Results

The results consist of current pole runs with simultaneous wind data. Runs were made on October 3, 4, 5, 6, 9, 11, 12, 13, 16, 17, and 20. Current velocity results and wind data are presented in Tables 3 through 15 and the trajectories of the current poles are given in Figures 2 through 14.

On October 4 and 17 there were wind shifts during the day. On these

days the current pole runs under way were terminated when the wind shifts became definite, and the poles were reset to obtain runs under the new winds. Separate tables and figures for the old and new winds of these days are given.

The wind directions under which results were obtained are summarized in Table 1.

Table 1. Wind directions observed at the two sites.

Five Mile Point site		Au Train site	
Date	winds from	Date	winds from
Oct. 6	NE	Oct. 16	NW
Oct. 3	NNW	Oct. 17	SW
Oct. 5	NNW	Oct. 17	SSW
Oct. 9	NW		
Oct. 11	NW		
Oct. 4	WNW		
Oct. 20	SWxW		
Oct. 12	S		
Oct. 13	SSE		
Oct. 4	SSE-SW		

At the Five Mile Point site the missing wind directions (SE, E, N, and W) are well enough bracketed by observed winds that the currents there may be considered quite well known. At the Au Train site the important northwest prevailing wind was observed.

In the run of October 6 (Figure 6), four of five current poles went aground on the shore. Their trajectories are shown in dashed lines because the time of grounding is not known and no current velocities could be computed. Similarly, on October 12 (Figure 9) pole #6 grounded on the south end of Wood Island; its reported velocity is computed from release to its last fixed position.

Attention is called to the fact that on October 20 (Figure 14) seas from the northwest were still running and may have added northwest-to-south-east components to the trajectories of the poles.

As a test of the general validity of our results we have computed mean current speeds as percentages of the mean winds. Primarily this is a test of whether direct wind pressure on the emergent portion of the current pole was introducing spurious elements of speed. If the indicated current speeds appear correct, then the poles were probably moving with the current alone. Moving with the current alone they would have little or no directional error from direct wind pressure. This test is shown in Table 2.

Table 2. Mean current speeds as percentages of mean wind speeds.

Table	Mean Current	Mean Wind	Current/Wind
3	0.347 mph	14.5 mph	2.39%
4	0.220	5.0	4.40%
5	0.216	5.0	4.40%
6	0.637	15.5	4.11%
7	0.310	13.0	2.38%
8	0.478	14.5	3.30%
9	0.333	14.5	2.30%
10	0.341	14.5	2.35%
11	0.446	26.0	1.72%
12	0.237	11.5	2.06%
13	0.524	17.5	2.99%
14	0.230	17.5	1.31%
15	0.447	17.5	2.55%
			Grand Mean 2.79%

The norm to which the test is compared is the finding in Lake Erie that the mean value of surface current is "about 2%" of the wind velocity (see Hutchinson A Treatise on Limnology, Volume I, John Wiley & Sons, New York, 1957, page 291). Within the limitations of the norm our results appear to be valid.

Conclusions

Current poles appear to have produced valid measures of the alongshore currents at the two plant sites.

Under the prevailing northwest winds at the Five Mile Point site, mill effluent will travel from the mill outfall to the mill intake, if the plant layout shown on drawing D-07-782-024 is followed.

Under the prevailing northwest winds, mill effluent from the Five Mile Point site will reach the Munising municipal intake with a degree of dilution presently not known. See Figure 8 particularly.

At the Au Train site the prevailing northwest wind moves alongshore current in a northwest-to-southeast direction around the promontory and into Au Train Bay. See Figure 11.

On the basis of currents under prevailing winds and the greater distance involved, better protection of the Munising water supply would be afforded if the mill were located on the Au Train site.

On the present evidence, winds from other than the northwest quarter appear to create no problems at either plant site.

Table 3

Figure 2

October 3, 1967

NNW wind

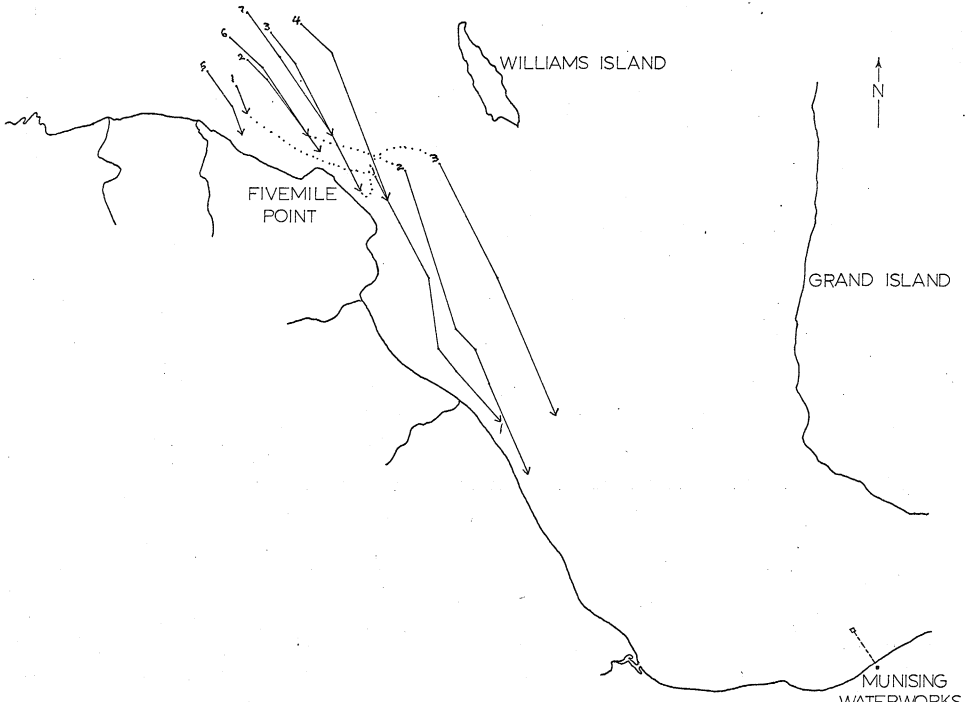

Figure 2. Pole runs, October 3, 1967. NNW wind.

Table 4

Figure 3

October 4, 1967

SSE-SW winds

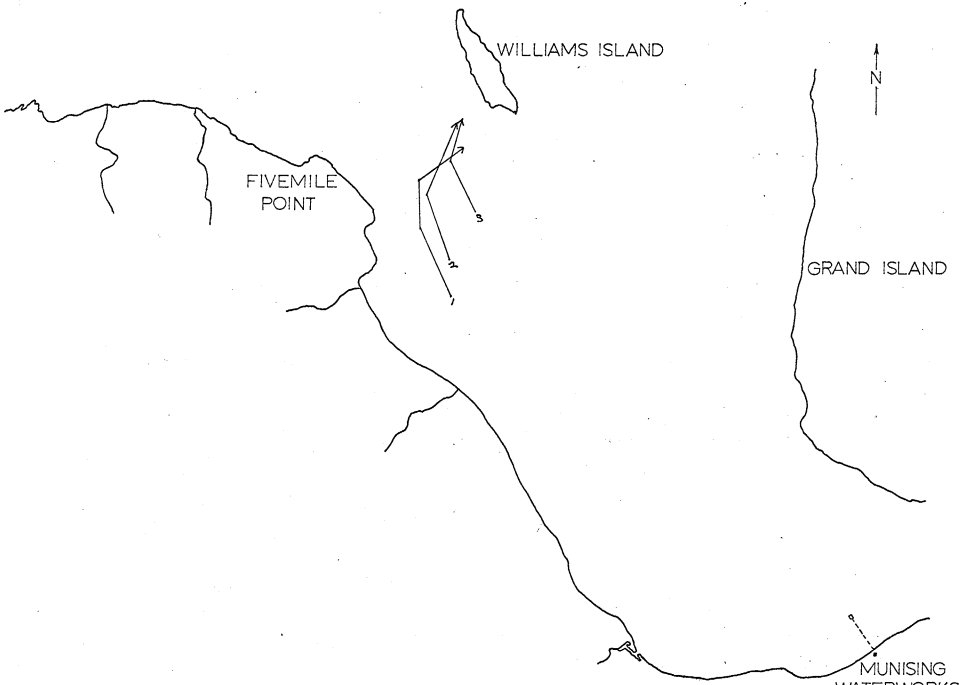

Figure 3. Pole runs, October 4, 1967. SSE-SW winds.

Table 5

Figure 4

October 4, 1967

WNW wind

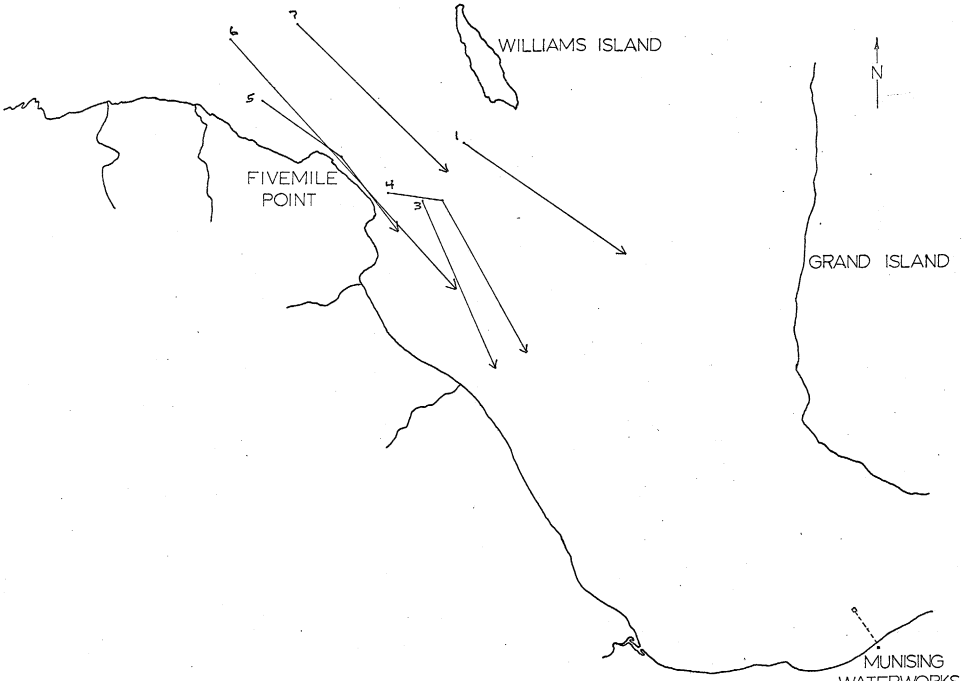

Figure 4. Pole runs, October 4, 1967. WNW wind.

Table 6

Figure 5

October 5, 1967

NNW wind

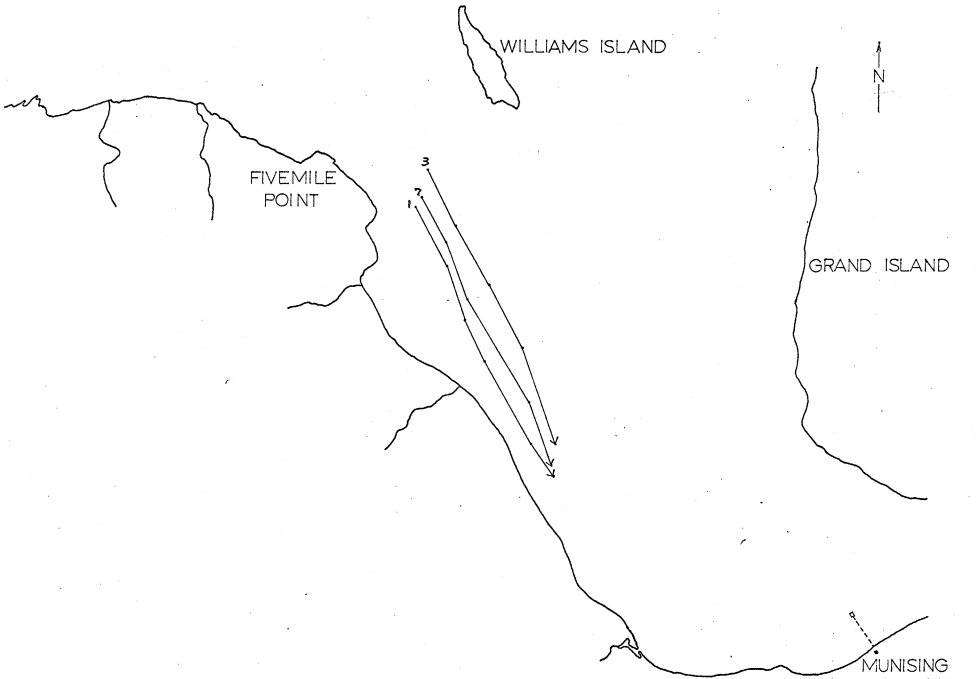

Figure 5. Pole runs, October 5, 1967. NNW wind.

Table 7

Figure 6

October 6, 1967

NE wind

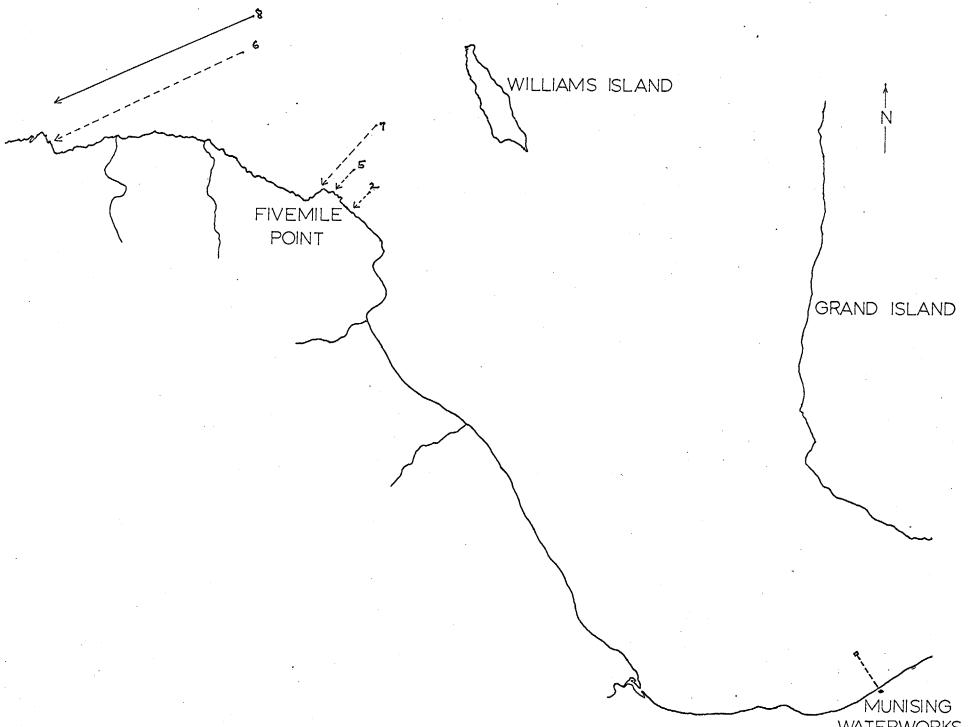

Figure 6. Pole runs, October 6, 1967. NE wind.

Table 8

Figure 7

October 9, 1967

NW wind

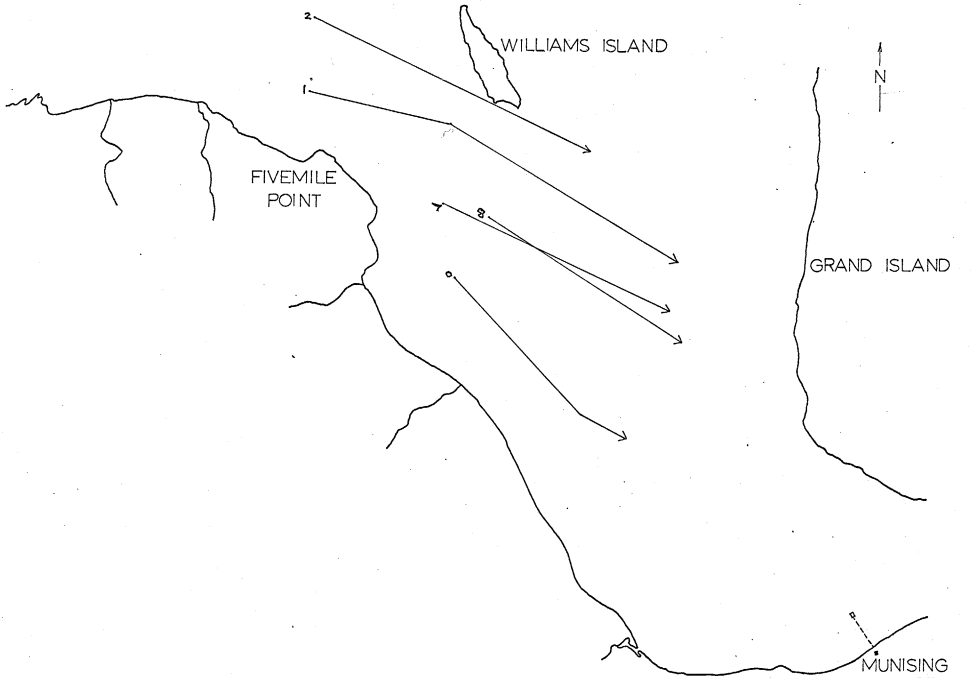

Figure 7. Pole runs, October 9, 1967. NW wind.

Table 9

Figure 8

October 11, 1967

NW wind

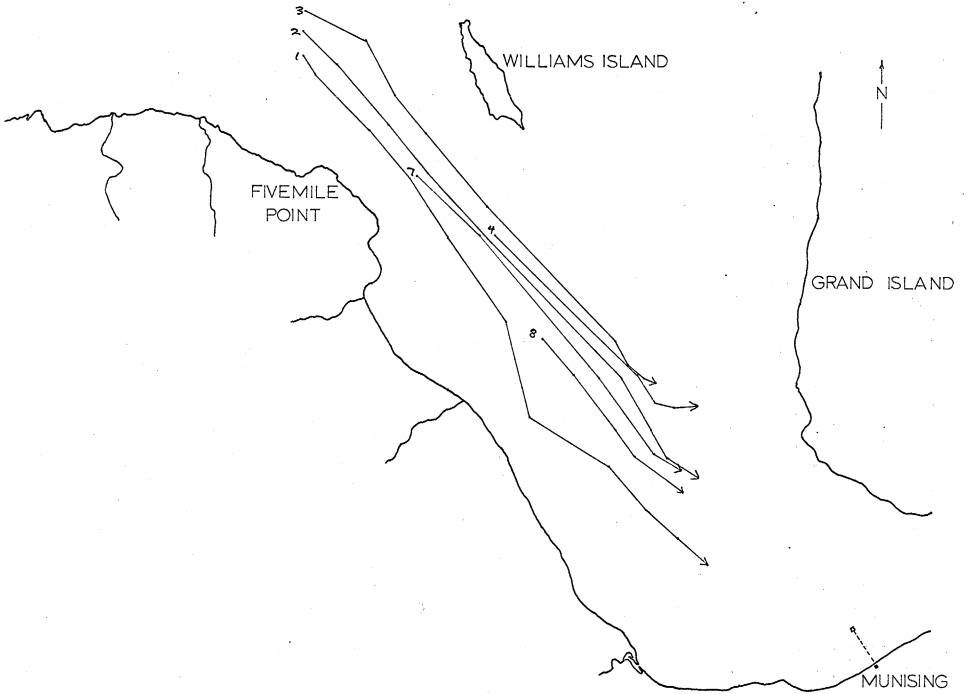

Figure 8. Pole runs, October 11, 1967. NW wind.

Table 10

Figure 9

October 12, 1967

S wind

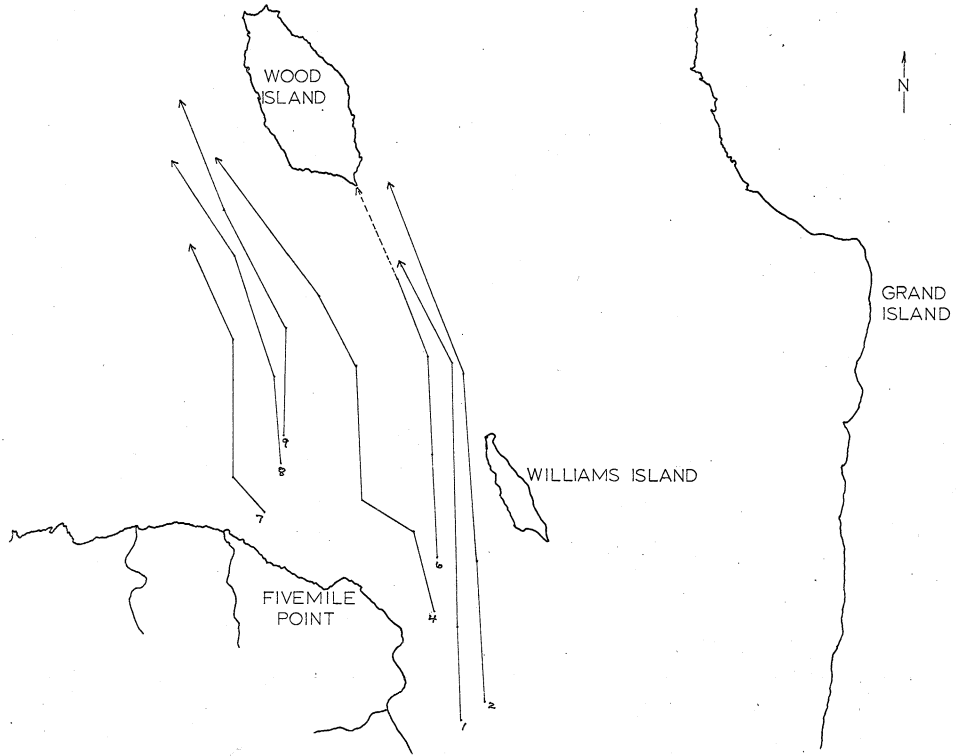

Figure 9. Pole runs, October 12, 1967. S wind.

Table 11

Figure 10

October 13, 1967

SSE wind

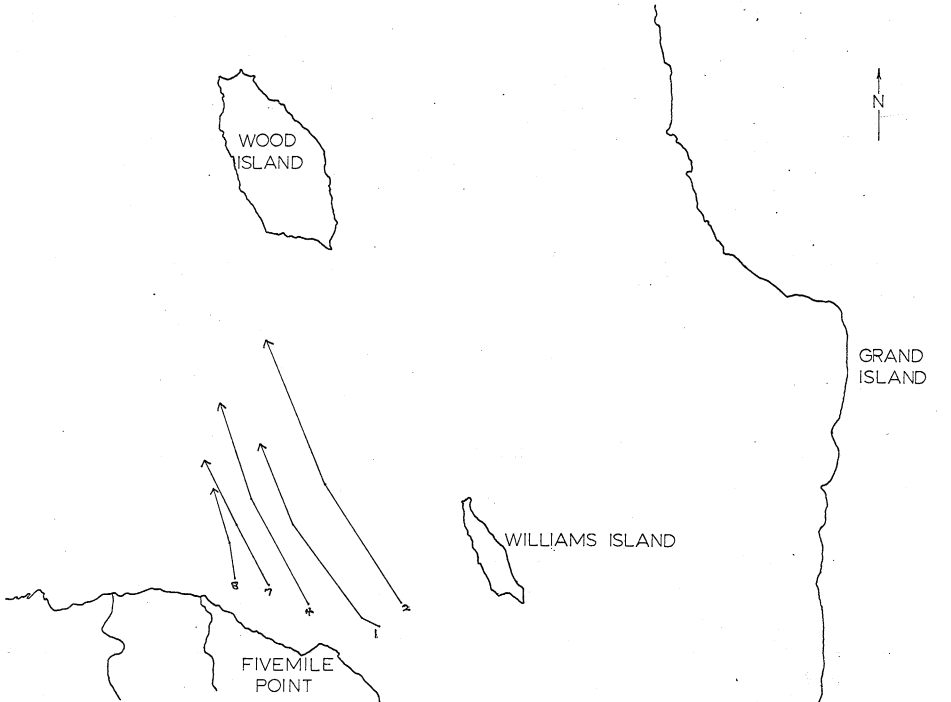

Figure 10. Pole runs, October 13, 1967. SSE wind.

Table 12

Figure 11

October 16, 1967

NW wind

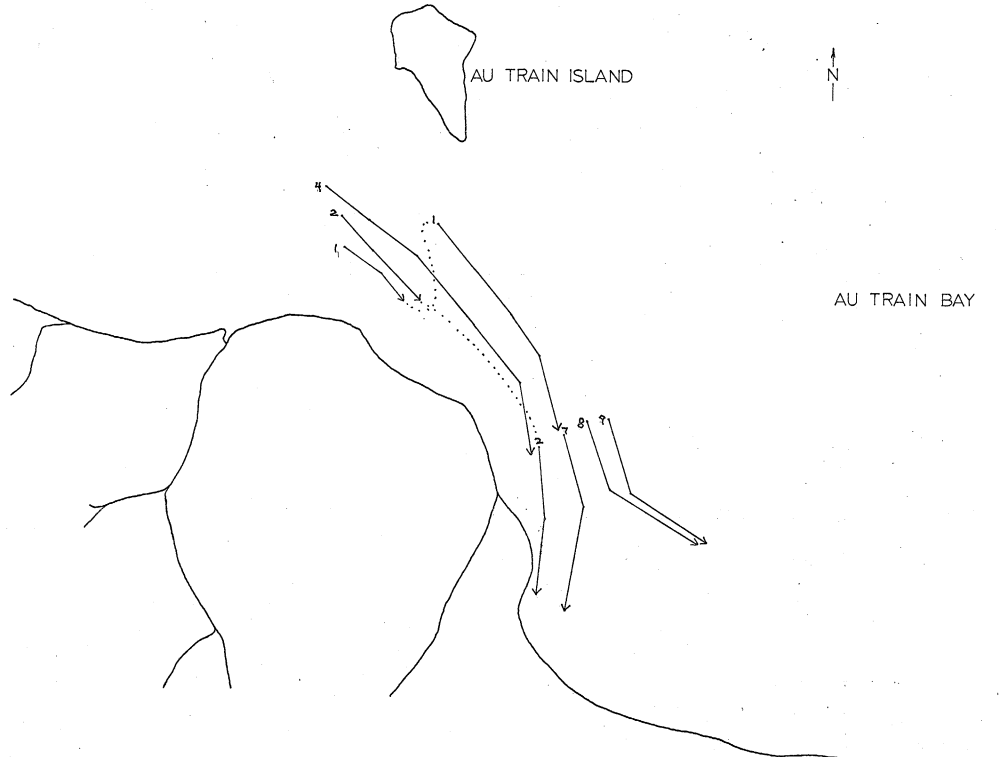

Figure 11. Pole runs, October 16, 1967. NW wind.

Table 13

Figure 12

October 17, 1967

SSW wind

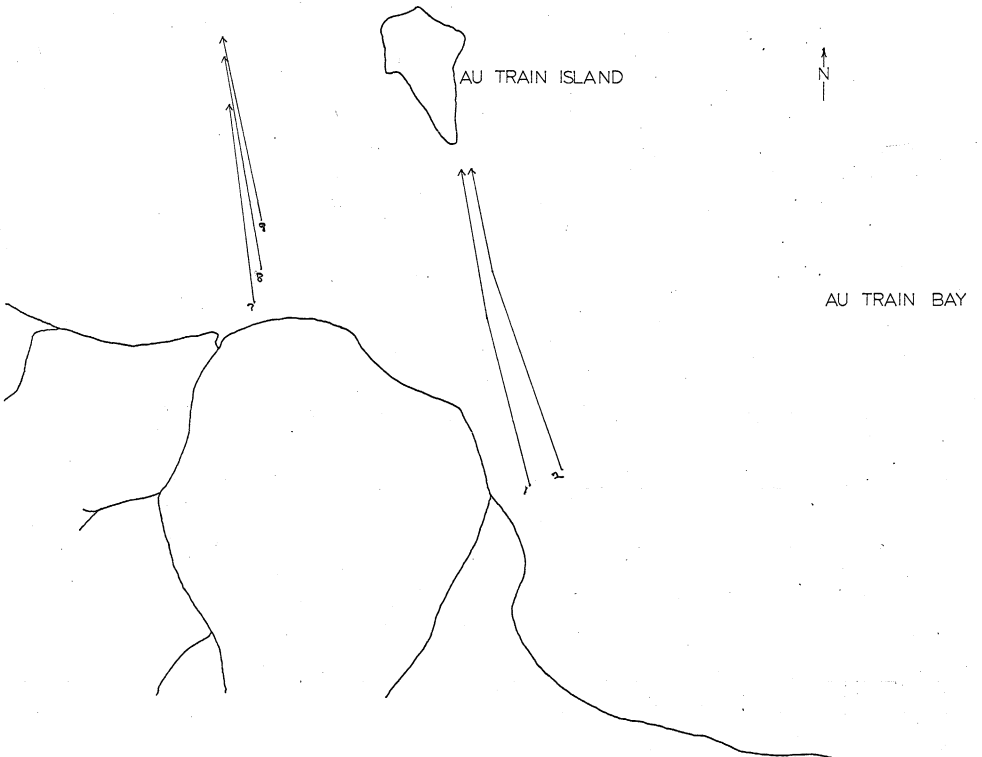

Figure 12. Pole runs, October 17, 1967. SSW wind.

Table 14

Figure 13

October 17, 1967

SW wind

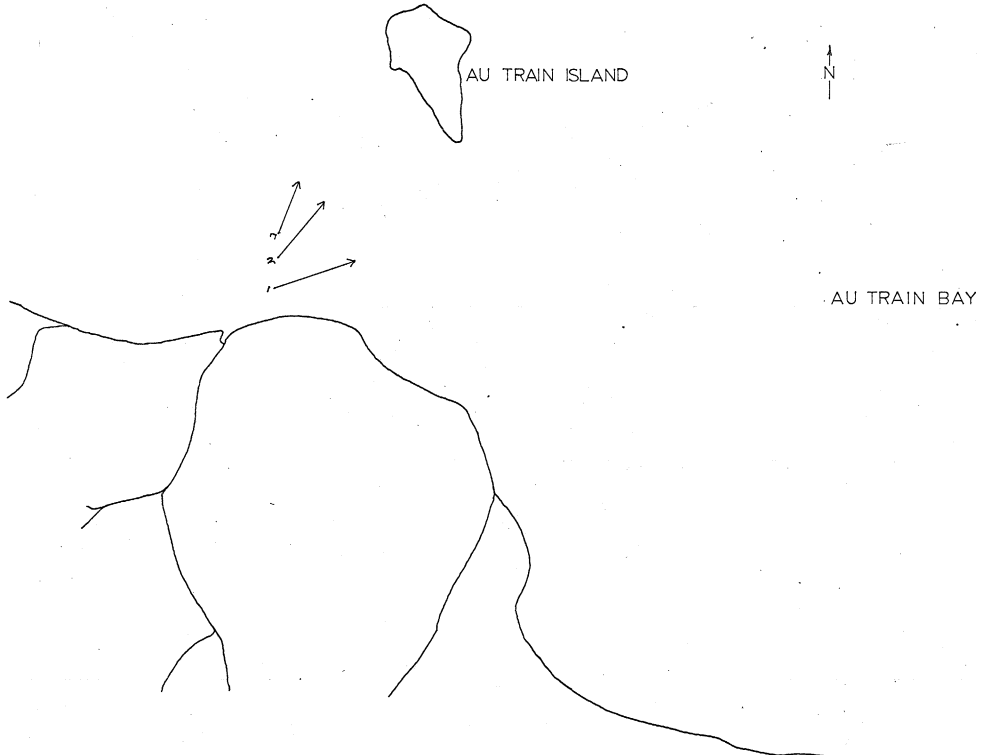

Figure 13. Pole runs, October 17, 1967. SW wind.

Table 15

Figure 14

October 20, 1967

SWxW wind

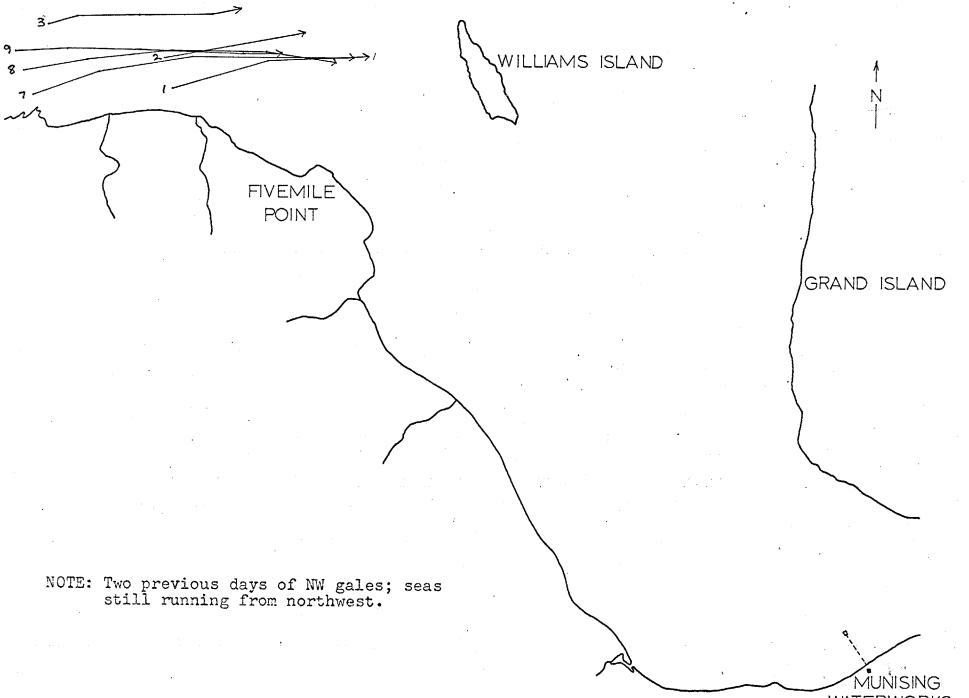

Figure 14. Pole runs, October 20, 1967. SWxW wind.